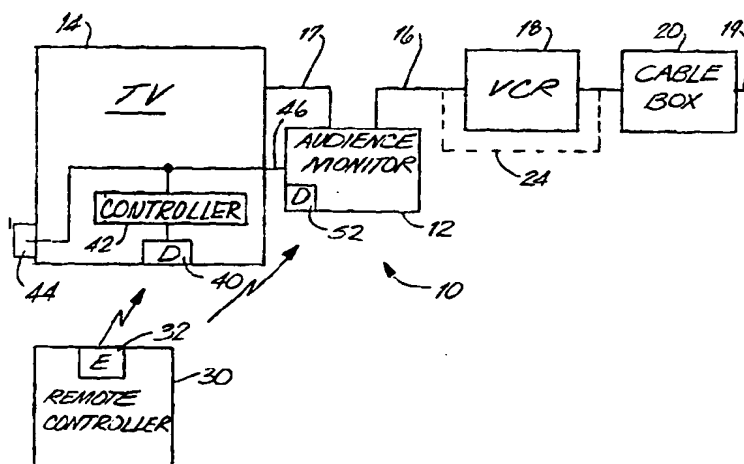




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification 6 :</b> <b>H04N 5/76</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 95/08242</b> <b>(43) International Publication Date:</b> 23 March 1995 (23.03.95)
<b>(21) International Application Number:</b> PCT/US94/10681 <b>(22) International Filing Date:</b> 16 September 1994 (16.09.94) <b>(30) Priority Data:</b> 08/122,146 16 September 1993 (16.09.93) US <b>(71)(72) Applicants and Inventors:</b> YUEN, Henry, C. [US/US]; P.O. Box 1159, Redondo Beach, CA 90278 (US). KWOH, Daniel, S. [US/US]; 3975 Hampstead Road, La Canada Flintridge, CA 91011 (US). <b>(74) Agent:</b> HARTZ, Edwin, L.; Christie, Parker & Hale, P.O. Box 7068, Pasadena, CA 91109-7068 (US).		<b>(81) Designated States:</b> AM, AT, AT (Utility model), AU, BB, BG, BR, BY, CA, CH, CN, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, ES, FI, FI (Utility model), GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, SK (Utility model), TJ, TT, UA, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i>

(54) Title: APPARATUS AND METHOD FOR USING COMPRESSED CODES



## (57) Abstract

An apparatus for television audience monitoring includes a device (12) and method for determining that a television set (14) is turned on. Compressed codes, each representative of, and compressed in length from, the combination of a channel and a time-of-day for a program are retrieved from a television signal received by a television set (14). Each compressed code is decoded and expanded into a channel and time-of-day for a program. The channel and time-of-day for a program are stored when the apparatus for determining that the television set (14) is turned on indicates that the television set (14) is turned on. Alternately, the compressed codes are stored. The decoding and expanding of the compressed code into channel and time-of-day is performed as a function of the clock output. Upon command the stored channel and time-of-day for a program or the stored compressed code for a program are sent over a telephone line.

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## APPARATUS AND METHOD FOR USING COMPRESSED CODES

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### Cross-Reference to Related Applications

15 This is a continuation-in-part of patent application Serial No. 08/031,246, filed March 12, 1993; which is a continuation-in-part of Serial No. 08/027, 202 filed March 5, 1993; which is a continuation-in-part of Serial No. 08/000,934, filed January 5, 1993; which is a continuation-in-part of Serial No. 07/965,075, filed October 22, 1992; which is a continuation of 07/877,687, filed May 1, 1992 abandoned; which is a continuation-in-part  
20 of 07/829,412, filed February 3, 1992; which is a continuation-in-part of 07/767,323, filed September 30, 1991, abandoned; which is a continuation-in-part of 07/676,934, filed March 27, 1991 which is a continuation-in-part of Serial No. 07/371,054 filed June 26, 1989, abandoned; which was a continuation-in-part of Serial No. 07/289,369, filed December 23, 1988,  
25 abandoned. The above referenced applications are incorporated herein by reference.

### Background of the Invention

30 This invention relates to apparatus and methods for monitoring the audiences of television programs.

Advertising rates for commercials of television programs are determined by the expected size of the viewer audience. These expectations are usually determined by the estimated audience sizes of the previously broadcast shows. For example, a weekly television series will estimate its  
35 audience size for upcoming episodes based on the estimated viewers of previously broadcast shows. Advertising rates may be adjusted based on an "after the fact" estimation of the market share for the televised program.

1       The present systems for estimating market share involve survey evidence  
such as the Neilson ratings. The Neilson ratings are determined by selected  
households which record their viewing habits. For example, a selected  
household might record in a written journal or diary when they turn on and  
5       off the television, what channels are selected and the number of viewers in  
the room. The viewership data may alternately be collected by providing the  
user with an electronic device which will record the time the television is on  
and the channel selected. In one implementation, the user is provided with  
a remote controller, or there is a button on the electronic device, that the  
10       user pushes when turning on and off the television. The channel tuner is  
monitored electronically to determine the channel selected.

      Television in the United States is broadcast in a frame format with the  
odd number lines being scanned during the first field of a frame and the even  
number lines being scanned during the second field of a frame. Between  
15       fields it is necessary for the beam to move or fly back to the upper left corner  
or upper middle of the screen. During the fly back interval in which the beam  
returns to the top, the picture on the television is blank. This period of time  
is called a vertical blanking interval (VBI). The vertical blanking interval can  
be used to broadcast additional information. For example, close captioning  
20       for the deaf is broadcast during a portion of the vertical blanking interval.

      The vertical blanking interval can be used to broadcast program  
information synchronous with the program being transmitted. For example,  
the title of the program, channel number and time of the broadcast can all be  
broadcast in the vertical blanking interval. Electronic devices are available for  
25       audience monitoring that can decode the vertical blanking interval and read  
the program information from the vertical blanking interval and store it in a  
memory. Then on command the memory can be dumped over a telephone  
line to a central computer for analysis. A shortcoming of this approach is  
that the program information requires an extensive amount of the vertical  
30       blanking interval. It is important to efficiently use the limited vertical blanking  
interval, because there are increasing demands to include other information  
in the vertical blanking interval, such as an electronic television guide.

      Accordingly, there is a need in the art for an apparatus and method for  
using compressed codes for audience monitoring, which would consume  
35       significantly less of the vertical blanking interval than the combination of a  
channel number and a time of broadcast for a program. There is also the  
need in the art for reducing the amount of information which must be stored

1 in an electronic device for audience monitoring and for reducing the amount of information that must be transmitted over telephone lines from the audience monitoring device to a central computer facility.

5 **Summary of the Invention**

According to the present invention, methods and apparatus for television audience monitoring are provided.

In an embodiment of the present invention, an apparatus for television audience monitoring comprises means for determining that a television is turned on, means for retrieving compressed codes, each representative of, and compressed in length from, the combination of a channel and a time-of-day for a program from a television signal received by the television, means for decoding and expanding each compressed code into a channel and time-of-day for a program, and means for storing the channel and time-of-day for a program when the means for determining that a television set is turned on indicates that the television set is turned on.

In a specific embodiment, the apparatus further comprises a clock for providing an output as a function of time coupled to the means for decoding and expanding, and the means for decoding and expanding a compressed code into channel and time-of-day performs the decoding and expanding as a function of the clock output.

In another specific embodiment the means for decoding and expanding the compressed code into channel and time-of-day further comprises means for converting the compressed code into a binary number, means for reordering the bits in the binary number to obtain a reordered binary compressed code, means for grouping the reordered binary compressed code into channel and time-of-day priority numbers, and means for using the channel and time-of-day priority numbers to derive the channel and time-of-day.

In yet another specific embodiment the means for determining that a television is turned on further comprises an infrared detector for sensing when an infrared emitter on a remote controller sends a power on command to a television.

35 In another specific embodiment the apparatus for audience monitoring measures the time that a program is "on" by observing when a compressed code retrieved from the television signal changes.

1           In another specific embodiment the means for retrieving a compressed code from a television signal coupled to the television comprises a vertical blanking interval decoder.

5           In another specific embodiment the apparatus for audience monitoring further comprises means for sending over a telephone line the stored channel and time-of-day for a program when commanded.

          In another specific embodiment the audience monitored further comprises means for sending the time a program is "on" over a telephone line.

10          In an alternate embodiment of the apparatus for audience monitoring, compressed codes, each representative of, and compressed in length from, the combination of a channel and a time-of-day for a program, are retrieved from a television signal received by the television and stored.

15          In a specific embodiment the apparatus for audience monitoring further comprises means for sending over a telephone line the stored compressed codes for a program when commanded.

20          In another embodiment, a method for television audience monitoring comprises the steps of determining that a television is turned on, retrieving compressed codes, each representative of, and compressed in length from, the combination of a channel and a time-of-day for a program from a television signal received by the television, decoding and expanding each compressed code into a channel and a time-of-day for a program, and storing the channel and time-of-day for a program when the television set is turned on.

25          In an alternate embodiment the method further comprises the steps of providing a clock having an output as a function of time, and performing the decoding and expanding of the compressed code into channel and time-of-day as a function of the clock output.

30          In yet another embodiment the step of decoding and expanding the compressed code into channel and time-of-day further comprises the steps of converting the compressed code into a binary number, reordering the bits in the binary number to obtain a reordered binary compressed code, grouping the reordered binary compressed code into channel and time-of-day priority numbers, and using the channel and time-of-day priority numbers to derive  
35          the channel and time-of-day.

          In another specific embodiment the step of determining that a television is turned on further comprises the step of providing an infrared

1 detector, and sensing when an infrared emitter on a remote controller sends a power on command to a television.

In another specific embodiment the step of storing further comprises the step of determining whether a compressed code is different from the last  
5 observed compressed code and if different then storing the compressed code.

In another specific embodiment, the method includes the step of measuring the duration that a program is "on" by observing when a compressed code read from the vertical blanking interval changes.

In yet another specific embodiment the method of audience monitoring  
10 further comprises the step of sending over a telephone line the stored channel and time-of-day for a program when commanded.

In another embodiment, a method for television audience monitoring comprises the steps of determining that a television is turned on, retrieving compressed codes, each representative of, and compressed in length from,  
15 the combination of a channel and a time-of-day, for a program from a television signal received by the television, and storing the compressed codes for a program when the television set is turned on.

In a specific embodiment the step of storing further comprises the step of determining whether a compressed code is different from the last observed  
20 compressed code and if different then storing the compressed code.

In yet another specific embodiment the method of audience monitoring further comprises the step of sending over a telephone line the stored compressed code for a program when commanded.

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1        **Brief Description of the Drawings**

         The features of specific embodiments of the best mode contemplated of carrying out the invention are illustrated in the drawings, in which:

         FIG. 1a is a block diagram illustrating an audience monitor used with  
5        a television and a cable box and with or without a VCR in accordance with principles of the invention.

         FIG. 1b is a block diagram illustrating an audience monitor used with a television in accordance with principles of the invention.

         FIG. 2 is a detailed block diagram illustrating an audience monitor used  
10        with a television in accordance with principles of the invention.

         FIG. 3 is a schematic of a processor for implementing the controller of an audience monitor in accordance with principles of the invention.

         FIG. 4 is a diagram illustrating the fields, frames and vertical blanking interval of an interlaced television scanning raster.

         FIG. 5 is a diagram illustrating the timing of the vertical blanking  
15        interval lines of an interlaced television scanning raster.

         FIG. 6 is a flowchart showing the steps employed in television audience monitoring in accordance with principles of the invention.

         FIG. 7 is a flowchart showing the steps employed in decoding the  
20        compressed code in accordance with principles of the invention.

         FIG. 8 is a flowchart showing the steps employed in encoding the compressed code in accordance with principles of the invention.

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1      **Detailed Description of the Specific Embodiments**

5      FIG. 1a is a block diagram illustrating an audience monitor 12 used with a television 14 and a cable box 20 and with or without a video cassette recorder (VCR) 18 in accordance with principles of the invention. In FIG. 1a, the broadband television signal on line 19 is first received by the cable box 20, which is tuned to the desired channel. If a VCR 18 is present, then it is tuned to channel 3 or 4 and outputs television channel signal on line 16. Alternately, the VCR 18 can be bypassed by connecting the cable box 20 directly to line 16 via cable 24. The television channel signal on line 16 is sent to audience monitor 12. As will be described, the audience monitor 12 decodes the vertical blanking interval (VBI) lines and retrieves from the VBI a compressed code uniquely representing the combination of channel, date and time-of-day and length for a received program. The audience monitor 12 then can directly store the compressed code and transmit it upon command to a central computer facility or the audience monitor 12 can decode the compressed code into channel, date, time-of-day and length and store this information for later transmission to a central computer facility. The audience monitor output is sent via line 17 to the television (TV) 14, which is tuned to channel 3 or channel 4, respectively.

20      It is necessary for the audience monitor 12 to know when the television (TV) 14 is "on." In one embodiment a remote controller 30 has an infrared emitter 32 and is used to turn on and off the television. The audience monitor 12 is provided with a infrared detector 52 to sense the on and off status of the television. In addition or alternately, the manual on/off switch 44 for the television (TV) 14 can be directly connected to the audience monitor 12 via line 46. The television (TV) 14 can also have an infrared detector 40 coupled to the controller 42 in the television (TV) 14. The controller 42 is connected to the audience monitor 12 via line 46.

25      The TV on/off signal is used by the audience monitor 12 to determine whether to decode the television signal vertical blanking interval line to obtain the compressed codes, as described in FIG. 6. If the TV is off then the audience monitor can be effectively in an off state.

30      FIG. 1b is a block diagram illustrating an audience monitor 12 used directly with a television 14 in accordance with principles of the invention. In FIG. 1b, the broadband television signal on line 19 is connected directly to the television tuner 26 in the television (TV) 14. The tuned television channel signal on line 28 is then connected to the television and to the input

1 54 of the audience monitor 12, which performs the same functions as  
described for the audience monitor 12 in FIG. 1a. The audience monitor 12  
in FIG. 1b again receives the TV on/off signal on line 46 from the television  
(TV) 14 or receives the on/off command from the remote controller 30 via  
5 the infrared detector 52.

FIG. 2 is a detailed block diagram illustrating an audience monitor 12  
in accordance with principles of the invention. The audience monitor 12  
includes: a VBI decoder 60 coupled to the television channel signal on line  
16; a compressed code decoder 62 coupled to the VBI decoder 60; a clock  
10 63 coupled to the code decoder 62; and a controller 64 coupled to the code  
decoder 62. Additionally, the audience monitor 12 can include a infrared  
detector 52 and a modem 66 coupled to a telephone line 68. The VBI  
decoder 60 decodes the television channel signal on line 16 and the code  
decoder 62 decodes the compressed codes contained in the VBI. The clock  
15 can be used by the code decoder 62 to perform the decoding. The controller  
64 provides a programmable controller for performing the logic of the  
audience monitor 12, including handling the TV on/off signal on line 46, and  
receiving commands and sending responses via the modem 66. The  
controller 64 can also be used to interpret commands received from the  
20 infrared detector 52. A separate connector 70 can be provided for directly  
interfacing to the audience monitor 12.

FIG. 3 is a schematic of a processor for implementing the controller 64  
of audience monitor 12. The controller 64 can be implemented with a  
microcontroller 80, which can include built in random access memory and  
25 read only memory. Alternately, external random access memory 82 and  
external ROM 84 can be provided. The input/output logic 86 would be used  
to interface between the microcontroller 80 and the interfaces of controller  
64, as shown in FIG. 2.

FIG. 4 is a diagram illustrating the fields, frames and vertical blanking  
30 interval of an interlaced television scanning raster 100. There are at least 20  
lines in the vertical blanking interval of each field. The first field 102 of the  
television signal has 20 vertical blanking internal lines and then starts at the  
upper left corner of the screen and writes lines 21, 22, .. 263. At the  
bottom of the screen the beam writing the screen retraces in a series of lines  
35 106 back to the top of the screen, as shown in FIG. 4. This is the vertical  
blanking interval. During the retrace the writing to the screen is blanked;  
however, because the television carrier signal is still present, additional

1 information can be sent during the vertical blanking interval. After the  
vertical blanking interval, the second field 104 is written on the screen and  
lines 283, 284, ... 525 are interleaved between the lines of the first field  
102. The two fields and the vertical blanking interval together constitute a  
5 frame. It is during a vertical blanking interval that a compressed code can be  
transmitted and received by audience monitor 12.

FIG. 5 is a diagram illustrating the timing 110 of the conventional  
vertical blanking interval lines 1 to 20 of field 1 and VBI lines 263 to 283 of  
field 2. As shown each vertical blanking interval line 112 occupies a portion  
10 of the time span. In the conventional art, unencoded program information  
116, including the channel number, date and time and length of broadcast  
and possibly the program title, is included in at least two of the vertical  
blanking interval lines. A compressed code 114, representative of, and  
compressed in length from, the combination of a channel, a date, a  
15 time-of-day, and a length for a program, is able to fit into only a single  
vertical blanking interval line. This provides an advantage over the  
conventional art, because fewer vertical blanking interval lines 112 are used.

FIG. 6 is a flowchart showing the steps employed in a method for  
television audience monitoring in accordance with principles of the invention.  
20 In step 130, a test is made to determine whether a television is turned on.  
If not then step 130 is repeated, otherwise in step 132 the VBI is decoded  
and a compressed code representative of, and compressed in length from, the  
combination of a channel, a date, a time-of-day, and a length for a program  
is extracted from the VBI. In step 134, a test is made to determine whether  
25 the extracted compressed code is different from the last observed  
compressed code. If not then step 130 is repeated. If the compressed code  
is different then the compressed code is decoded in step 136 to obtain a  
channel, a date, a time-of-day, and a length for a program being received by  
the television. In step 138 the compressed code or the decoded channel,  
30 date, time-of-day, and length for a program are stored in memory, such as  
the random access memory 82 shown in FIG. 3. In step 139, a timer is  
started to derive the duration a program is "on." The timer can be  
implemented with clock 63 and controller 64. The length of the program and  
the duration a program is "on" can be used together to detect how long the  
35 viewer watches a program and also how often channels are switched. The  
duration a program is "on" is stored in memory along with the compressed  
code or decoded channel, date, time-of-day and length of the program. Then

1 step 130 and the following steps are repeatedly executed. The purpose is  
to record program information in the memory for each program being received  
by the television when the television is on.

5 When a command is received either over a telephone line 68 or  
through connector 70, the compressed code or the decoded channel, date,  
time-of-day, and length for a program are read from memory in step 140, and  
transmitted over a telephone line 68 or other media in step 142. Also, the  
time the program is "on" can be read from memory and sent over the media.

10 FIG. 7 is a flow diagram of a preferred compressed code decoding  
technique which is similar to the VCR compressed codes described in PCT  
application WO 90/07844 to Yuen, et al. There are further compressed code  
techniques in WO 90/07844, which are incorporated herein by reference. To  
understand compressed code decoding, it is easiest to first explain the  
compressed code encoding technique, for which FIG. 8 is the flow chart.  
15 Then the compressed code decoding technique, which is the reverse of the  
compressed code encoding will be explained.

The encoding of the compressed codes can be done on any computer  
and is done prior to the inclusion of the compressed codes in the vertical  
blanking interval. For each program, a channel, date, time and length (CDTL)  
194 is entered in step 192. Step 196 separately reads the priority for the  
channel, date, time and length in the priority vector storage 172, which can  
be stored in a memory. The priority vector storage 172 contains four tables:  
a priority vector C table 174, a priority vector D table 176, a priority vector  
T table 178 and a priority vector L table 180.

25 The channel (C) priority table 174 is ordered so that the most  
frequently used channels have a low priority number. An example of the data  
that is in priority vector C table 174 follows.

30	channel	4	7	2	3	5	6	11	13	...
	priority	0	1	2	3	4	5	6	7	...

Generally the dates of a month all have an equal priority, so the low  
number days in a month and the low number priorities would correspond in  
the priority vector D table 176 as in the following example.

35	date		1	2	3	4	5	6	7	8	9	10...	
	priority		0	1	2	3	4	5	6	7	8	9	...

1           The priority of the start times would be arranged so that prime time  
would have a low priority number and programs in the dead of the night  
would have a high priority number. For example, the priority vector T table  
178 would contain:

5

time	6:30pm	7:00pm	8:00pm	7:30pm	...
priority	0	1	2	3	...

10

An example of the data that is in the priority vector L table 180 is the  
following:

length of program (hrs)	0.5	1.0	2.0	1.5	3.0	...
priority	0	1	2	3	4	...

15

Suppose the channel, date, time, and length (CDTL) 194 data is 5 10  
19.00 1.5, which means channel 5, 10th day of the month, 7:00 PM, and  
1.5 hours in length, then for the above example the  $C_p, D_p, T_p, L_p$  data 198,  
which are the result of looking up the priorities for channel, date, time and  
length in priority tables 174, 176, 178 and 180 of FIG. 8, would be 4 9 1  
3. Step 200 converts  $C_p, D_p, T_p, L_p$  data to binary numbers. The number of  
binary bits in each conversion is determined by the number of combinations  
involved. Seven bits for  $C_p$ , which can be denoted as  $C_7 C_6 C_5 C_4 C_3 C_2 C_1$ ,  
would provide for 128 channels. Five bits for  $D_p$ , which can be denoted  
as  $D_5 D_4 D_3 D_2 D_1$ , would provide for 31 days in a month. Six bits for  $T_p$ ,  
which can be denoted as  $T_6 T_5 T_4 T_3 T_2 T_1$ , would provide for 48 start  
times on each half hour of a twenty four hour day. Four bits for length,  
which can be denoted as  $L_4 L_3 L_2 L_1$ , would provide for a program length of  
up to 8 hours in half hour steps. Together there are  $7+5+6+4 = 22$  bits  
of information, which correspond to  $2^{22} = 4,194,304$  combinations.

30

The next step is to use bit hierarchy key 170, to reorder the 22 bits.  
The bit hierarchy key 170 can be any ordering of the 22 bits. For example,  
the bit hierarchy key might be:

35

$L_8$	$C_3 \dots T_2$	$C_2$	$T_1$	$C_1$	$L_1$	$D_5$	$D_4$	$D_3$	$D_2$	$D_1$
22	21 .. 10	9	8	7	6	5	4	3	2	1

1            Ideally the bit hierarchy key is ordered so that programs most likely to  
 be the subject of timer preprogramming would have a low value binary  
 number, which would eliminate keystrokes for timer preprogramming the  
 most popular programs. Since all the date information has equal priority,  
 5            then the  $D_5 D_4 D_3 D_2 D_1$  bits are first. Next  $T_1 C_1 L_1$  are used, because for  
 whatever date it is necessary to have a time channel and length and  $T_1 C_1$   
 $L_1$  are the most probable in each case due to the ordering of the priority  
 vectors in priority vector storage 172. The next bit in the hierarchy key is  
 10            determined by the differential probabilities of the various combinations. One  
 must know the probabilities of all the channels, times and lengths for this  
 calculation to be performed.

For example, the probability for channels may be:

15	channel	4	7	2	3	5	6	11	13...
	priority	0	1	2	3	4	5	6	7 ...
	probability(%)	5	4.3	4	3	2.9	2.1	2	1.8..

The probabilities for times might be:

20	time	6:30pm	7:00pm	8:00pm	7:30pm	...
	priority	0	1	2	3	...
	probability(%)	8	7.8	6	5	...

25            And, the probabilities for lengths might be:

	length of program (hours)	0.5	1.0	2.0	1.5	3.0	...
	priority	0	1	2	3	4	...
	probability(%)	50	20	15	5	4	...

30

            The probabilities associated with each channel, time and length, as  
 illustrated above, are used to determine the proper ordering. Since the  
 priority vector tables are already ordered by the most popular channel, time,  
 and length, the order in which to select between the various binary bits for  
 one table, for example selecting between the  $C_7 C_6 C_5 C_4 C_3 C_2 C_1$  bits, is  
 35            already known. The  $C_1$  bit would be selected first because as the lowest  
 order binary bit it would select between the first two entries in the channel

1 priority table. Then the  $C_2$  bit would be selected and so on. Similarly, the  
 $T_1$  and  $L_1$  bits would be used before any of the other time and length bits.  
 A combination of the  $C_1$ ,  $T_1$ ,  $L_1$  and  $D_5 D_4 D_3 D_2 D_1$  bits should be used  
 5 first, so that all the information is available for a channel, date, time and  
 length. The  $D_5 D_4 D_3 D_2 D_1$  bits are all used because the date bits all have  
 equal priority and all are needed to specify a date even if some of the bits are  
 binary zero.

At this point the bit hierarchy key could be:

10  $T_1 C_1 L_1 D_5 D_4 D_3 D_2 D_1$

The first channel binary bit  $C_1$  by itself can only select between  $2^1 = 2$   
 channels, and the first two channels have a probability percent of 5 and 4.3,  
 respectively. So the differential probability of  $C_1$  is 9.3. Similarly, the  
 15 differential probability of  $T_1$  is  $8 + 7.8 = 15.8$ , and the differential  
 probability of  $L_1$  is  $50 + 20 = 70$ . If the rules for ordering the bit hierarchy  
 key are strictly followed, then the first 8 bits of the bit hierarchy key should  
 be ordered as:

20  $C_1 T_1 L_1 D_5 D_4 D_3 D_2 D_1,$

because  $L_1$  has the highest differential priority so it should be next most  
 significant bit after  $D_5$ , followed by  $T_1$  as the next most significant bit, and  
 then  $C_1$  as the next most significant bit. Notice that the bit hierarchy key  
 25 starts with the least significant bit  $D_1$ , and then is filled in with the highest  
 differential probability bits. This is for the purpose of constructing the most  
 compact codes for popular programs.

The question at this point in the encoding process is what should the  
 next most significant bit in the hierarchy key be:  $T_2$ ,  $C_2$ , or  $L_2$ . This is again  
 30 determined by the differential probabilities, which can be calculated from the  
 above tables for each bit. Since we are dealing with binary bits, the  $C_2$  in  
 combination with  $C_1$  selects between  $2^2 = 4$  channels or 2 more channels  
 over  $C_1$  alone. The differential probability for  $C_2$  is then the additional  
 probabilities of these two additional channels and for the example this is:  $4$   
 35  $+ 3 = 7$ . In a similar manner  $C_3$  in combination with  $C_1$  and  $C_2$  selects  
 between  $2^3 = 8$  channels or  $4 = 2^{(3-1)}$  more channels over the combination  
 of  $C_1$  and  $C_2$ . So the differential probability of  $C_3$  is the additional

1 probabilities of these four additional channels and for the example this is:  $2.9 + 2.1 + 2 + 1.8 = 8.8$ . In a similar manner, the differential probabilities of  $T_2$  and  $L_2$  can be calculated to be  $6 + 5 = 11$  and  $15 + 5 = 20$ , respectively. Once all the differential probabilities are calculated, the next  
5 step is determining which combinations of bits are more probable.

Now for the above example, which combination is more probable:  $T_2$  with  $C_1 L_1$ , or  $C_2$  with  $T_1 L_1$ , or  $L_2$  with  $T_1 C_1$ . This will determine the next bit in the key. So, which is greater:  $11 \times 9.3 \times 70 = 7161$ ;  $7 \times 15.8 \times 70 = 7742$ ; or  $20 \times 15.8 \times 9.3 = 2938.8$ ? In this case the combination with the greatest  
10 probability is  $7 \times 15.8 \times 70 = 7742$ , which corresponds to  $C_2$  with  $T_1 L_1$ . So,  $C_2$  is selected as the next bit in the bit hierarchy key. The next bit is selected in the same way. Which combination is more probable:  $C_3$  with  $T_1 L_1$ , or  $T_2$  with  $C_1$  or  $C_2$  and  $L_1$ , or  $L_2$  with  $C_1$  or  $C_2$  and  $T_1$ . For the example shown, which has the greatest probability:  $8.8 \times 15.8 \times 70 = 9732.8$ ;  
15  $11 \times (9.3 + 7) \times 70 = 12551$ ; or  $20 \times (9.3 + 7) \times 15.8 = 5150.8$ ? In this case the combination with the greatest probability is  $11 \times (9.3 + 7) \times 70 = 12551$ , which corresponds  $T_2$  with  $C_1$  or  $C_2$  and  $L_1$ . So,  $T_2$  is selected as the next bit in the bit hierarchy key. This procedure is repeated for all the differential probabilities until the entire key is found.

20 Alternately, the bit hierarchy key can be just some arbitrary sequence of the bits. It is also possible to make the priority vectors interdependent, such as making the length priority vector dependent on different groups of channels. Another technique is to make the bit hierarchy key 170 and the priority vector tables 172, a function of clock 63, as shown in FIG. 8. This  
25 makes it very difficult for the key and therefore the coding technique to be duplicated or copied.

For example it is possible to scramble the date bits in the bit hierarchy key 170 as a function of the clock. Changing the order of the bits as a function of the clock would not change the effectiveness of the bit hierarchy  
30 key in reducing the number of binary bits for the most popular programs, because the date bits all are of equal priority. This could be as simple as switching the  $D_1$  and  $D_5$  bits periodically, such as every day or week. Thus the bit hierarchy key 170 would switch between

35 ...  $C_1 T_1 L_1 D_5 D_4 D_3 D_2 D_1$  and

...  $C_1 T_1 L_1 D_1 D_4 D_3 D_2 D_5$ .

1 Clearly other permutations of the bit hierarchy key as a function of the clock are possible.

5 The priority vector tables could also be scrambled as a function of the clock. For example, the first two channels in the priority channel table could just be swapped periodically. If this technique is followed, then the  $C_p$  of 198 in FIG. 8 would change as a function of the clock 63. For example,

channel 4	7	2	3	5	6	11	...
priority 0	1	2	3	4	5	6 7	...

10

would change periodically to:

channel	7	4	2	3	5	6	11...
priority	0	1	2	3	4	5	6 7...

15

This would be a fairly subtle security technique, because a decoder that was otherwise correct would only fail if those first two channels were being used. Other clock dependencies are also possible to provide security for the coding technique.

20

However it is derived, the bit hierarchy key 170 is determined and stored. In step 204 the binary bits of  $C_p, D_p, T_p, L_p$  are rearranged according to the bit hierarchy key 170 to create one 22 bit binary number. Then the resulting 22 bit binary number is converted to decimal in the convert binary number to decimal compressed code step 206. The result is compressed code 208.

25

If the priority vector and the bit hierarchy key are well matched to the viewing habits of the general population, then it is expected that the more popular programs would require no more than 3 or 4 digits for the compressed code.

30

Now that the encoding technique has been explained the decoding technique is just reversing the coding technique. This is done according to the flow chart of FIG. 7. This is the preferred compressed code decoding that can be built into compressed code decoder 62 in FIG. 2.

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The first step 152 is to enter compressed code 154. Next the compressed code 154 is converted to a 22 bit binary number in step 156. Then the bits are reordered in step 158 according to the bit hierarchy key 170 to obtain the reordered bits 160. Then the bits are grouped together and

1 converted to decimal form in step 162. As this point we obtain  $C_p, D_p, T_p, L_p$   
data 164, which are the indices to the priority vector tables. For the above  
example, we would have at this step the vector 4 9 1 3. This  $C_p, D_p, T_p, L_p$   
5 data 164 is then used in step 166 to look up channel, date, time, and length  
in priority vector storage 172. The CDTL 168 for the example above is 5 10  
19.00 1.5, which means channel 5, 10th day of the month, 7:00 PM, and  
1.5 hours in length.

If the coding technique is a function of the clock then it is also  
necessary to make the decoding technique a function of the clock. It is  
10 possible to make the bit hierarchy key 170 and the priority vector tables 172,  
a function of clock 63, as shown in FIG. 7. This again makes it very difficult  
for the key and therefore the coding technique to be duplicated or copied.  
It is also possible to have the decoding and encoding techniques dependent  
on any other predetermined or preprogrammable algorithm.

15 Although the above compressed code encoding and decoding  
technique is a preferred embodiment, it should be understood that there are  
many ways to encode and decode a compressed code and the scope of the  
invention is not to be restricted to the coding method described herein.

Thus, there has been described apparatus and methods for using  
20 compressed codes for audience monitoring, which consume significantly less  
of the vertical blanking interval than the combination of a channel, a date, a  
time-of-day, and a length for a program. There has also been described  
apparatus and methods for reducing the amount of information which must  
be stored in an electronic device for audience monitoring and for reducing the  
25 amount of information that must be transmitted over telephone lines from an  
audience monitoring device to a central computer facility.

The described embodiments of the invention are only considered to be  
preferred and illustrative of the inventive concept, the scope of the invention  
is not to be restricted to such embodiments. Various and numerous other  
30 arrangements may be devised by one skilled in the art without departing from  
the spirit and scope of this invention.

For example, instead of embedding the compressed codes in the  
vertical blanking interval lines of the television signal, the compressed codes  
can be placed anywhere in the television signal. For example, the  
35 compressed codes can be placed in the audio signal or be placed within the  
lines that are put onto the screen, such as line 22 of FIG. 4. If the  
compressed code is time shared with the actual video on line 22 and if the

1 compressed code is put on line 22 only on every fourth frame, for example,  
then the viewer would see only the actual video.

It is also possible to have compressed codes that only encode the  
channel and the time-of-day information for a program because that is  
5 sufficient if the audience monitor is accessed daily.

It is therefore intended by the appended claims to cover any and all  
such applications, modifications and embodiments within the scope of the  
present invention.

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**1 WHAT IS CLAIMED IS:**

1. An apparatus for television audience monitoring comprising:  
means for determining that a television is turned on;  
5 means for retrieving compressed codes, each representative of,  
and compressed in length from, at least the combination of a channel and a  
time-of-day, for a program from a television signal received by the television;  
means for decoding and expanding each compressed code into  
a channel and time-of-day for a program; and  
10 means for storing the channel and time-of-day for a program  
when the means for determining that a television set is turned on indicates  
that the television set is turned on.

**15            2.** The apparatus of Claim 1, further comprising:

**a**

clock for providing an output as a function of time coupled to the means for  
decoding and expanding; and

the means for decoding and expanding a compressed code into  
channel and time-of-day performs the decoding and expanding as a function  
of the clock output.

3. The apparatus of Claim 2 wherein the means for decoding and expanding the compressed code into channel and time-of-day further comprises:

means for converting the compressed code into a binary  
25 number;  
means for reordering the bits in the binary number to obtain a  
reordered binary compressed code;  
means for grouping the reordered binary compressed code into  
channel and time-of-day priority numbers; and  
30 means for using the channel and time-of-day priority numbers  
to derive the channel and time-of-day.

4. The apparatus of Claim 2 wherein the means for determining that a television is turned on further comprises an infrared detector for sensing when an infrared emitter on a remote controller sends a power on command to a television.

1           5.     The apparatus of Claim 2, further comprising means for  
determining and storing a duration a first program is "on" during which a  
compressed code for the first program is retrieved from the television signal  
before a compressed code for a second program is retrieved from the  
5     television signal.

          6.     The apparatus of Claim 2 wherein the means for retrieving a  
compressed code from a television signal comprises a vertical blanking  
interval decoder.

10           7.     The apparatus of Claim 2 further comprising means for sending  
over a telephone line the stored channel and time-of-day for a program when  
commanded.

15           8.     The apparatus of claim 7 further comprising means for sending  
over a telephone line a stored value of a duration a first program is "on."

          9.     An apparatus for television audience monitoring comprising:  
                  means for determining that a television is turned on;  
20                means for retrieving compressed codes, each representative of,  
and compressed in length from, the combination of a channel and a  
time-of-day for a program from a television signal received by the television;  
and  
                  means for storing the compressed code for a program when the  
25                means for determining that a television set is turned on indicates that the  
television set is turned on.

30           10.    The apparatus of Claim 9 wherein the means for determining  
that a television is turned on further comprises an infrared detector for  
sensing when an infrared emitter on a remote controller sends a power on  
command to a television.

35           11.    The apparatus of Claim 9, further comprising means for  
determining and storing a duration a first program is "on" during which a  
compressed code for the first program is retrieved from the television signal  
before a compressed code for a second program is retrieved from the  
television signal.

1           12. The apparatus of Claim 9 wherein the means for retrieving a compressed code from a television signal comprises a vertical blanking interval decoder.

5           13. The apparatus of Claim 9 further comprising means for sending over a telephone line the stored compressed code for a program when commanded.

10           14. The apparatus of claim 13 further comprising means for sending over a telephone line a stored value of a duration a first program is "on."

15           15. A method for television audience monitoring comprising the steps of:  
              determining that a television is turned on;  
              retrieving compressed codes, each representative of, and compressed in length from, the combination of a channel and a time-of-day for a program from a television signal received by the television;  
              decoding and expanding each compressed code into a channel and time-of-day for a program; and  
20           storing the channel and time-of-day for a program when the television set is turned on.

25           16. The method of Claim 15, further comprising the steps of:  
              providing a clock having an output as a function of time; and  
              performing the decoding and expanding of the compressed code into channel and time-of-day as a function of the clock output.

30           17. The method of Claim 16 wherein the step of decoding and expanding the compressed code into channel and time-of-day further comprises the steps of:  
              converting the compressed code into a binary number;  
              reordering the bits in the binary number to obtain a reordered binary compressed code;  
              grouping the reordered binary compressed code into channel and time-of-day priority numbers; and  
35           using the channel and time-of-day priority numbers to derive the channel and time-of-day.

1           18. The method of Claim 16 wherein the step of determining that  
a television is turned on further comprises the step of:  
            providing an infrared detector; and  
            sensing when an infrared emitter on a remote controller sends  
5 a power on command to a television.

            19. The method of Claim 16 wherein the step of storing further  
comprises the step of determining whether a compressed code is different  
from the last observed compressed code and if different then storing the  
10 compressed code.

            20. The method of Claim 16 further comprising the step of  
determining and storing a duration a first program is "on" during which a  
compressed code for the first program is retrieved from the television signal  
15 before a compressed code for the second program is retrieved from the  
television signal.

            21. The method of Claim 16 further comprising the step of sending  
over a telephone line the stored channel and time-of-day for a program when  
20 commanded.

            22. The method of claim 21 further comprising the step of sending  
over a telephone line a stored value of a duration a first program is "on."

25           23. A method for television audience monitoring comprising the  
steps of:

            determining that a television is turned on;  
            retrieving compressed codes, each representative of, and  
compressed in length from, the combination of a channel and a time-of-day  
30 for a program from a television signal received by the television; and  
            storing the compressed codes for a program when the television  
set is turned on.

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1           24. The method of Claim 23 wherein the step of determining that  
a television is turned on further comprises the step of:  
            providing an infrared detector; and  
            sensing when an infrared emitter on a remote controller sends  
5 a power on command to a television.

            25. The method of Claim 23 wherein the step of storing further  
comprises the step of determining whether a compressed code is different  
from the last observed compressed code and if different then storing the  
10 compressed code.

            26. The method of Claim 23 further comprising the step of  
determining and storing a duration a first program is "on" during which a  
compressed code for the first program is retrieved from the television signal  
15 before a compressed code for a second program is retrieved from the  
television signal.

            27. The method of Claim 23 further comprising the step of sending  
over a telephone line the stored compressed code for a program when  
20 commanded.

            28. The method of claim 27 further comprising the step of sending  
over a telephone line a stored value of a duration a first program is "on."  
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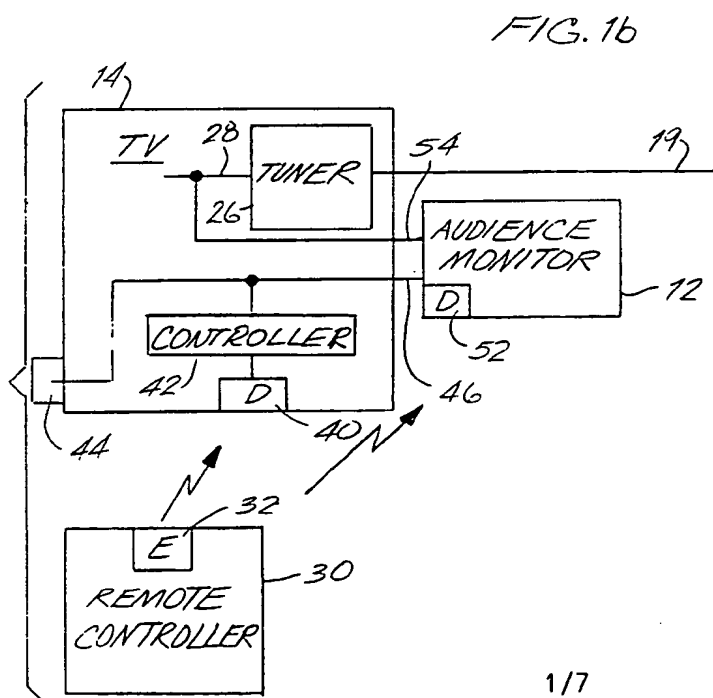
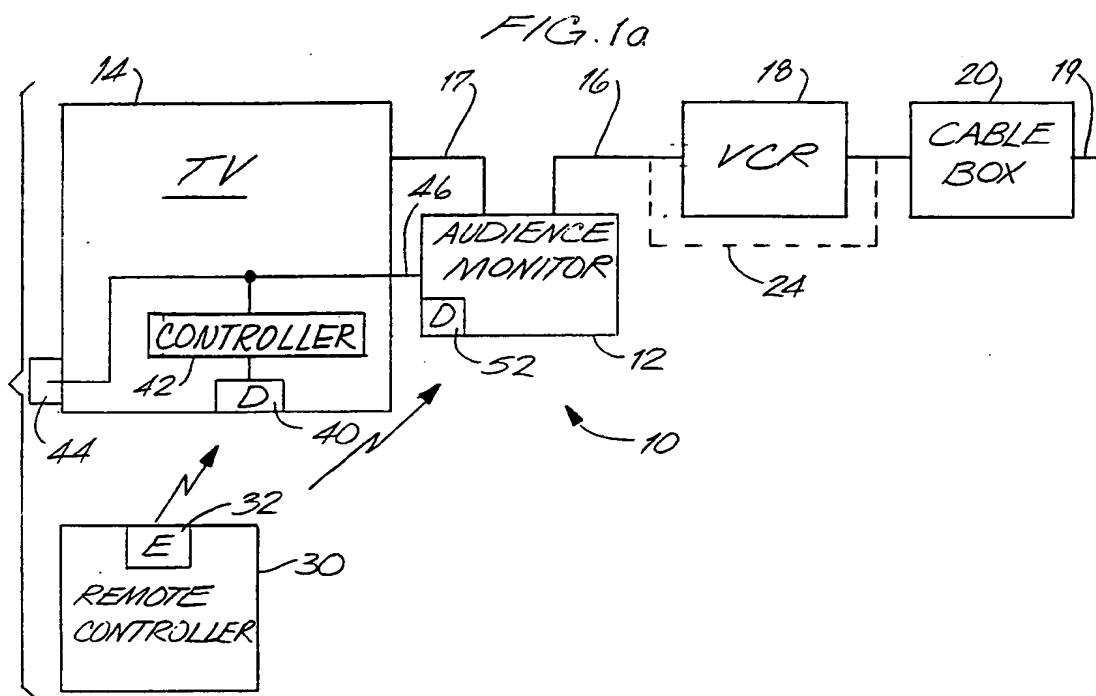


FIG. 2

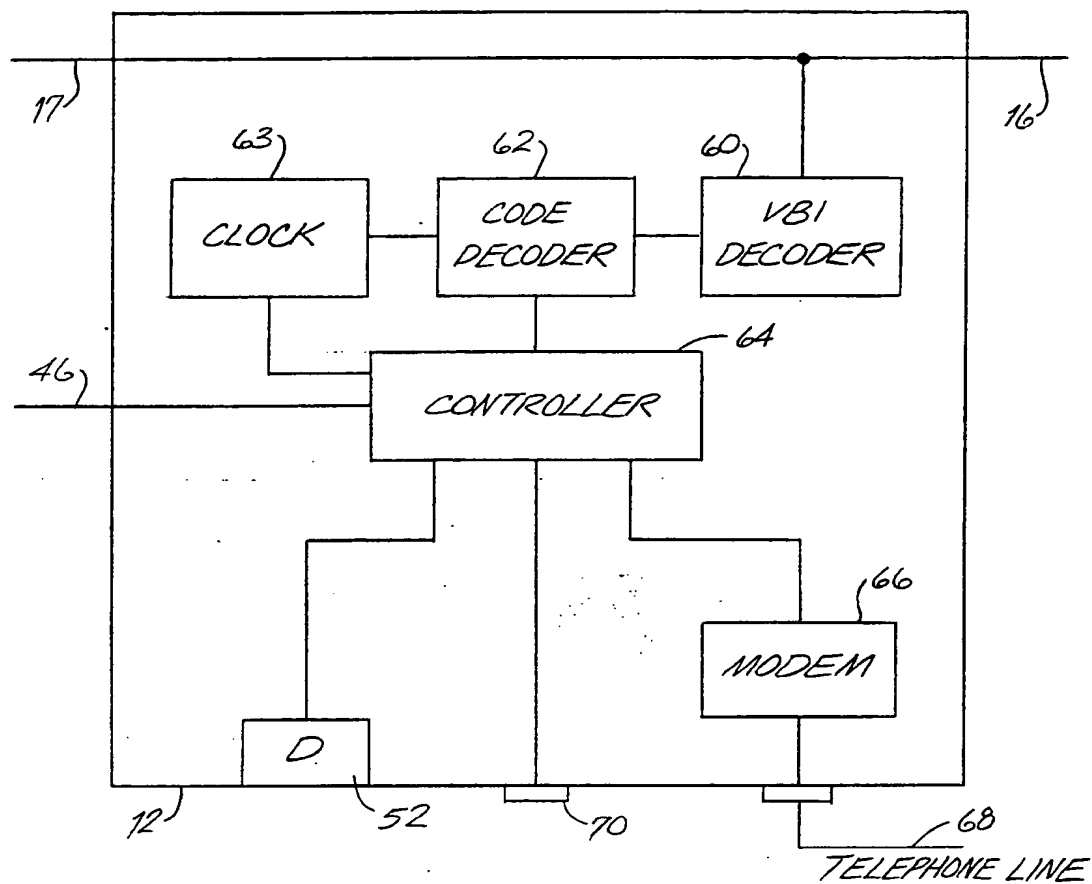
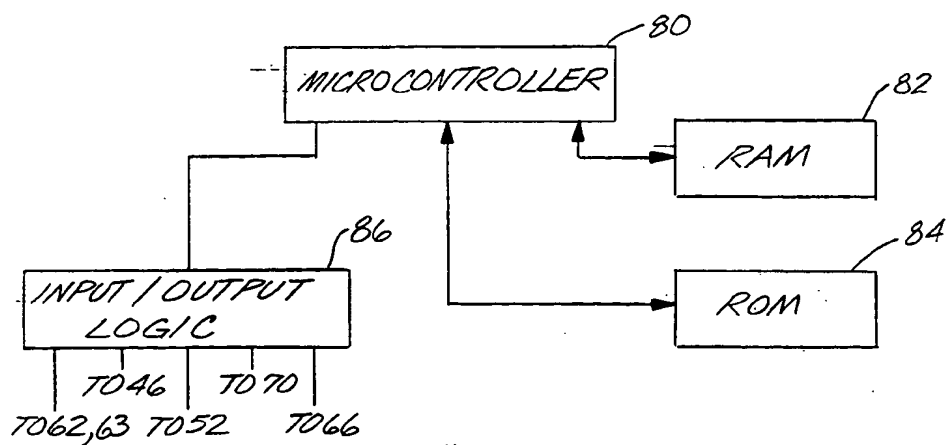


FIG. 3



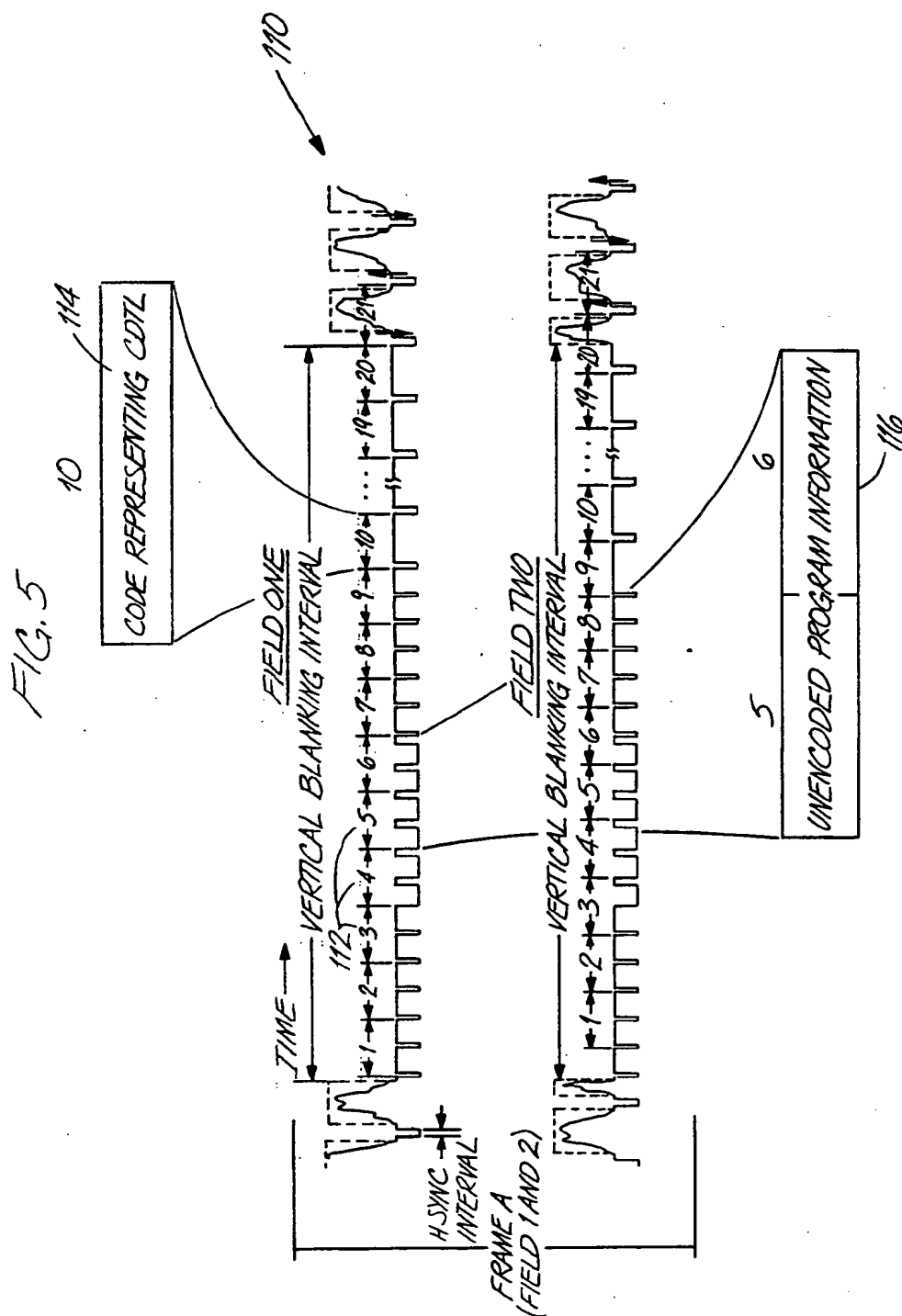
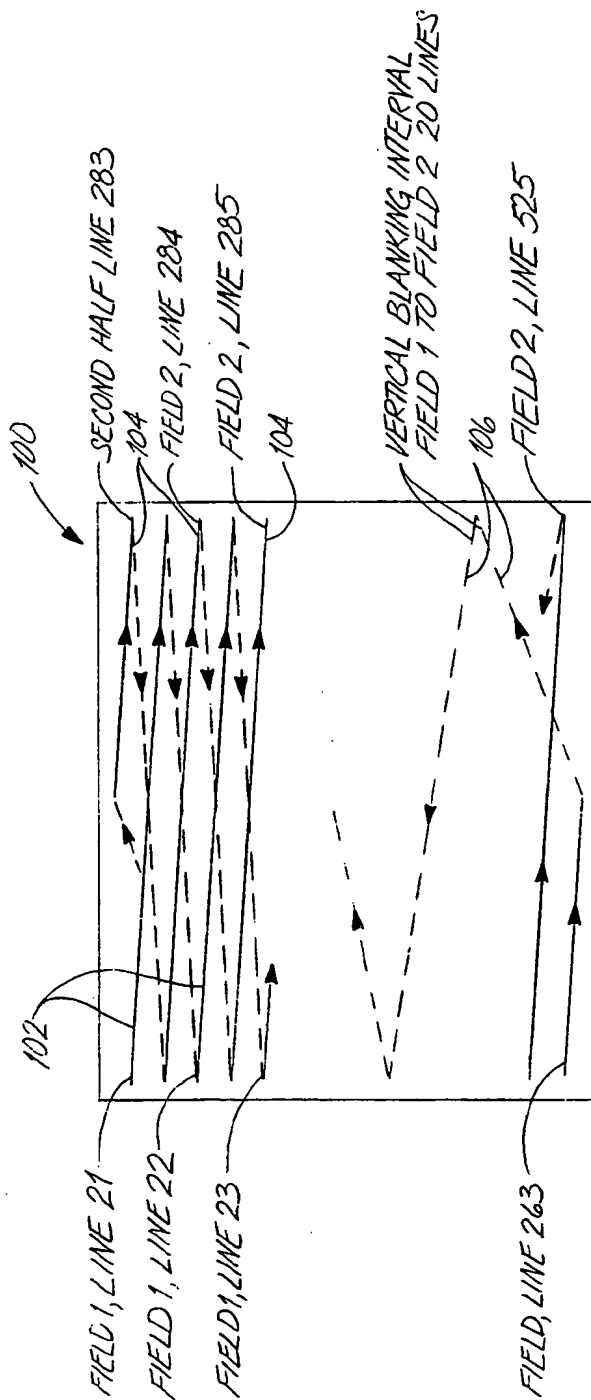
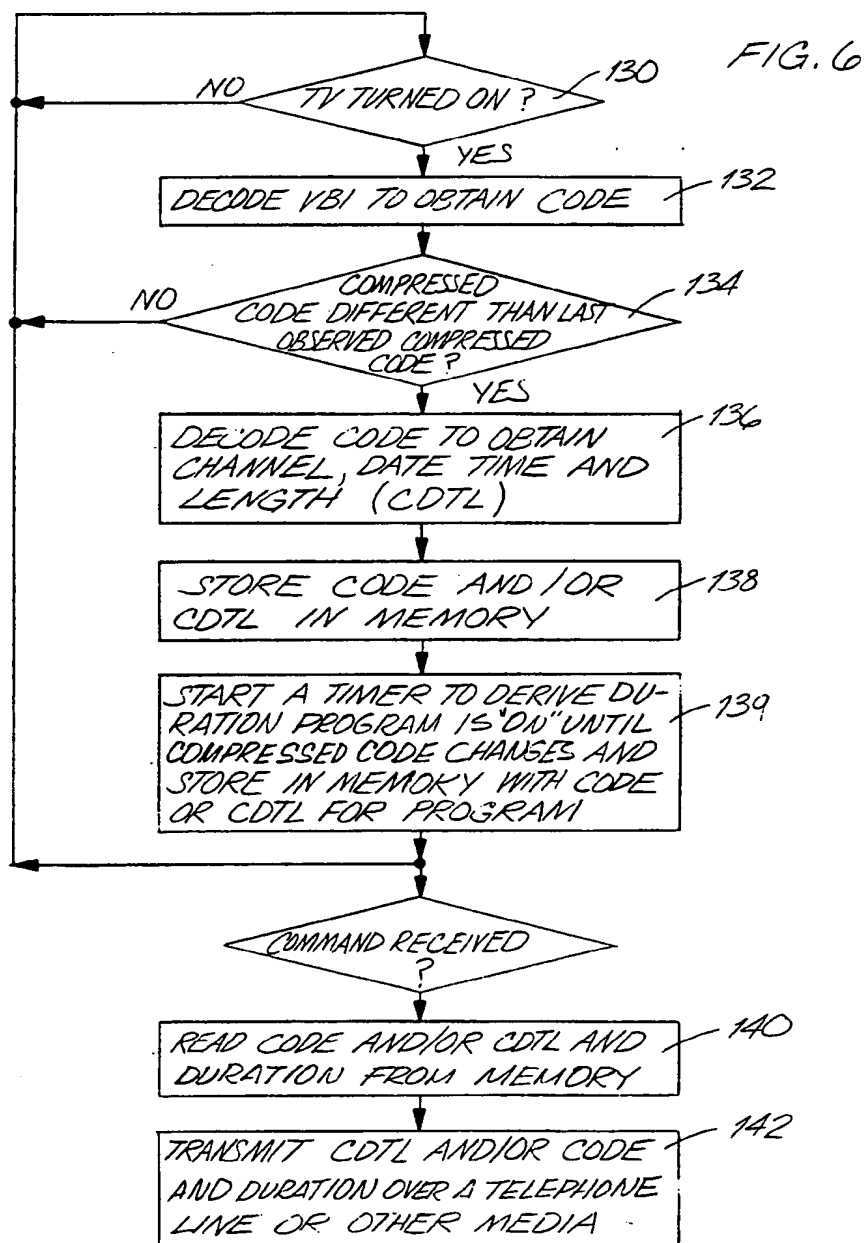
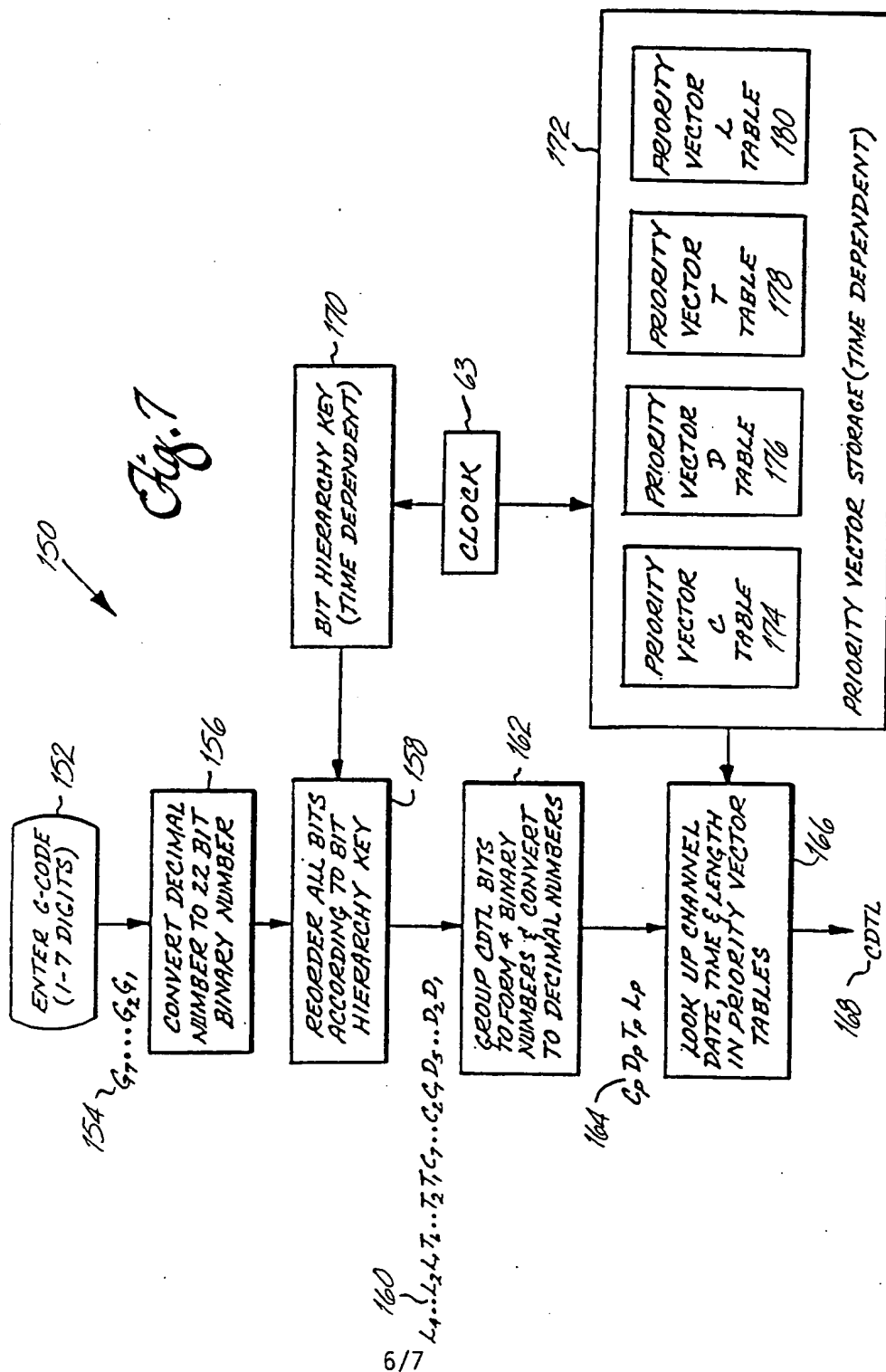


FIG. 4  
PRIOR ART







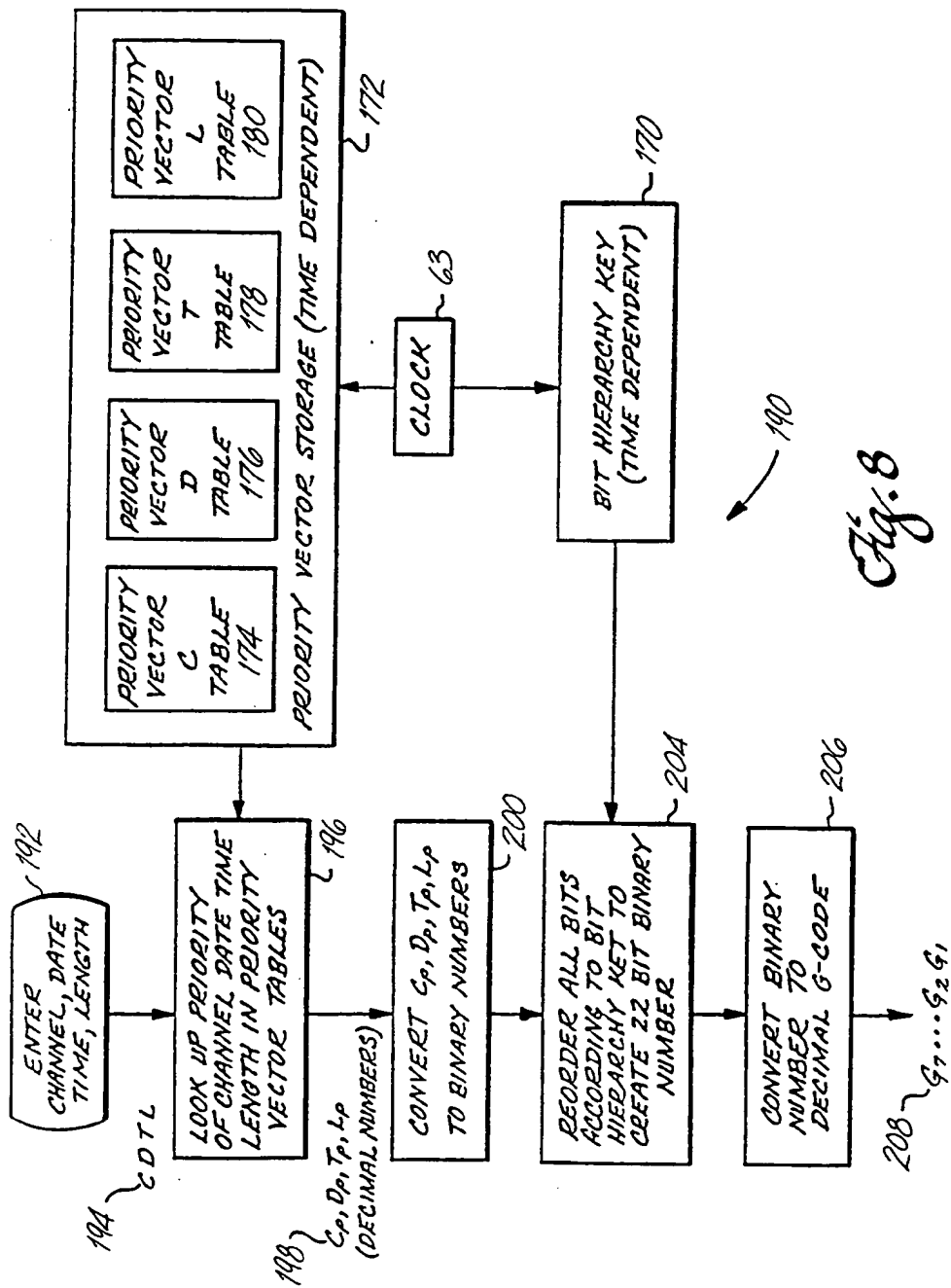


Fig. 8

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US94/10681

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :H04N 5/76

US CL :358/335

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 358/335, 310; 360/33.1; 348/731,732,734; 455/179.1, 184.1, 185.1, 186.1, 186.2; H04N 5/76, 5/765, 5/775, 5/44, 5/50, 5/92, 7/79

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,963,994 (LEVINE) 16 October 1990, columns 3-6 and Fig. 2.	1-2, 4-6, 7-12, 13-16, 18-24, and 26-28
Y	US, A, 4,866,434 (KEENAN) 12 September 1989, columns 5-6 and Fig. 4.	1-2, 4-5, 7-11, 13-16, 18, 20-24, and 26-28
Y	US, A, 4706121 (YOUNG) 10 November 1987, column 6 and column 20.	6, 12, 19, and 25
A	US, A, 5,166,911 (MISAWA ET AL.) 24 November 1992, Fig. 1.	1-28
A	US, A, 5,187,589 (KONO ET AL.) 16 February 1993, Fig. 6.	1-28

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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*P* document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

10 JANUARY 1995

Date of mailing of the international search report

07 FEB 1995

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